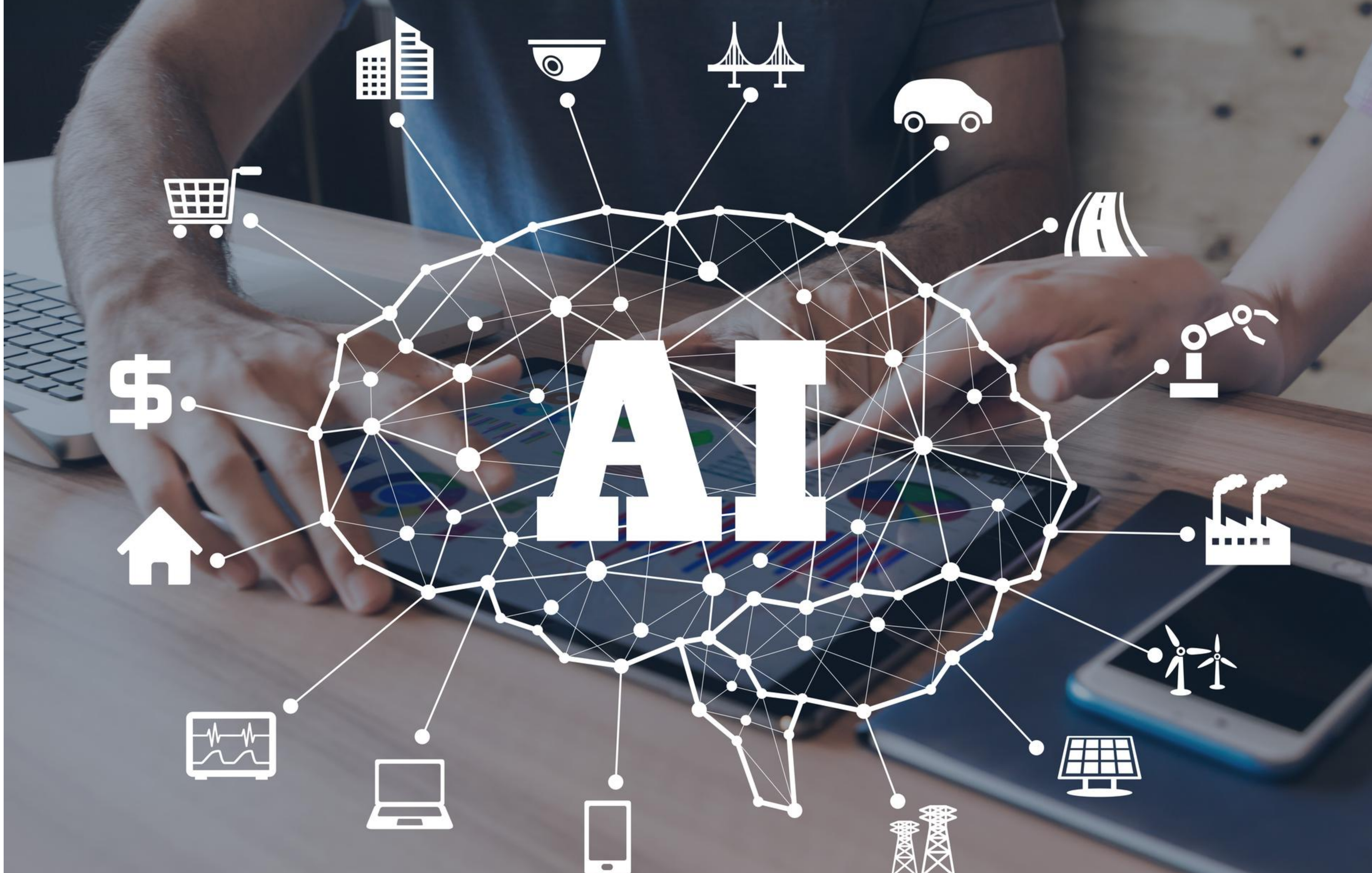# CS 540 Introduction to Artificial Intelligence
Course Overview

Yingyu Liang
University of Wisconsin-Madison
Sept 14, 2021

Based on slides created by Sharon Li
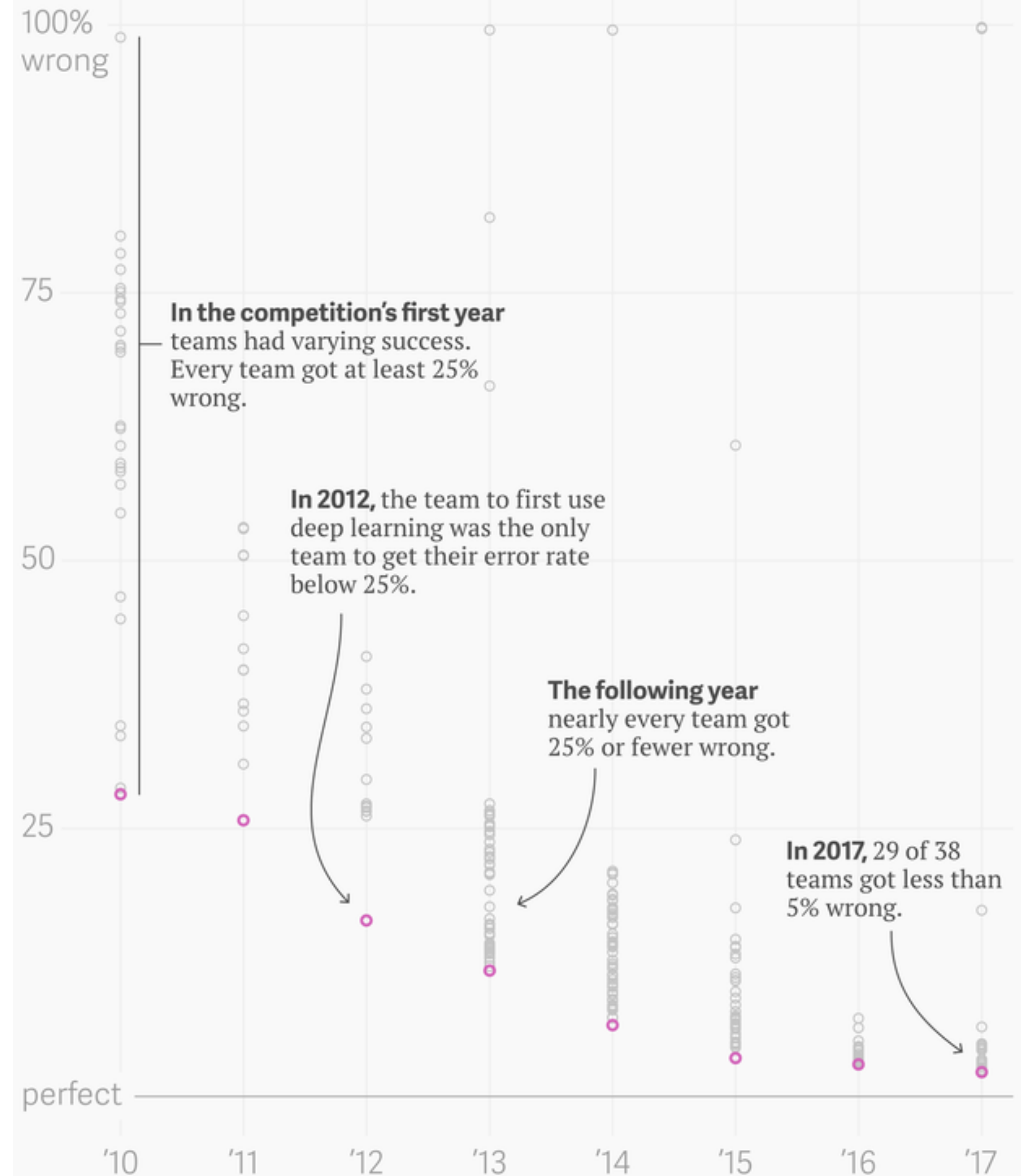
Classify Images

http://www.image-net.org/

Classify Images

ImageNet Large Scale Visual Recognition Challenge results

100% wrong

75

In the competition's first year teams had varying success. Every team got at least 25% wrong.

In 2012, the team to first use deep learning was the only team to get their error rate below 25%.

50

The following year nearly every team got 25% or fewer wrong.

25

In 2017, 29 of 38 teams got less than 5% wrong.

perfect

'10 '11 '12 '13 '14 '15 '16 '17

Detect and Segment Objects

https://github.com/matterport/Mask_RCNN
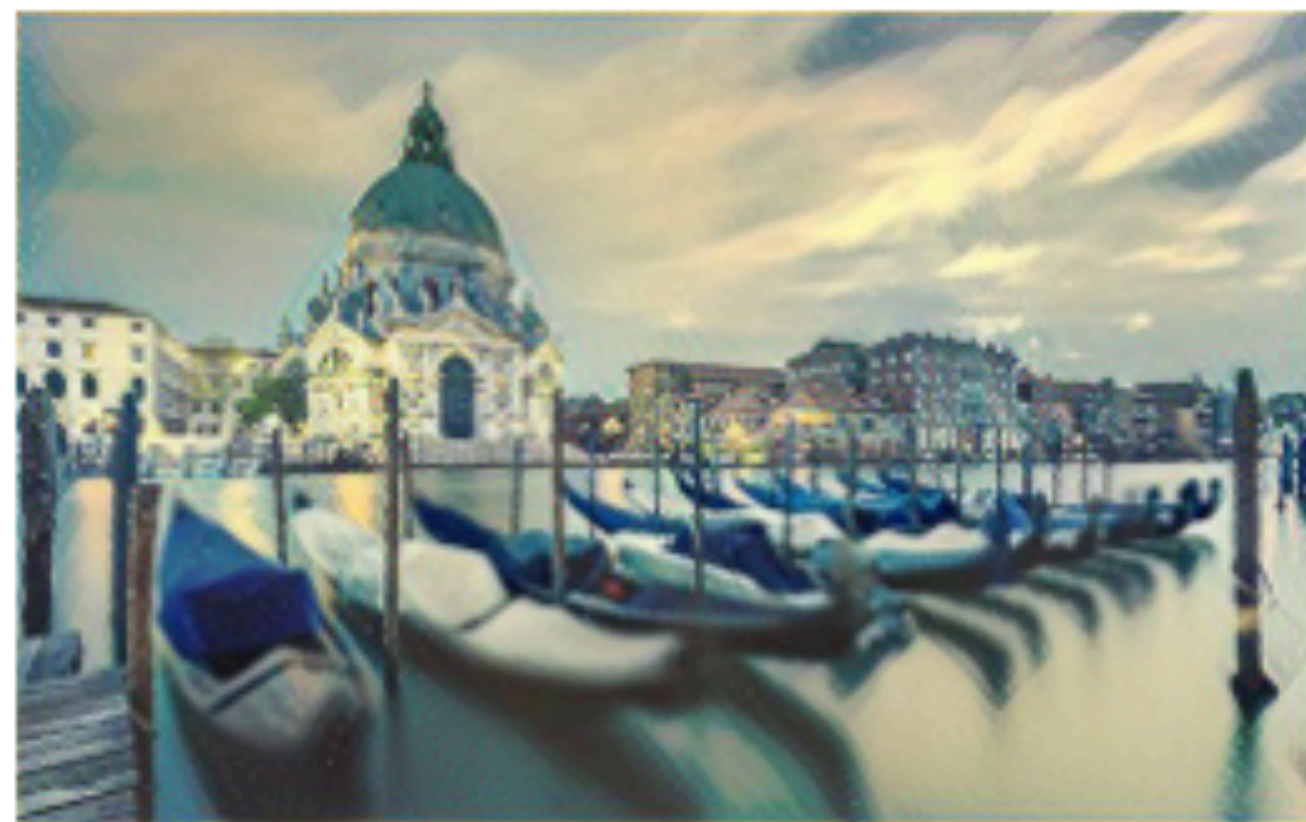
Style Transfer

https://github.com/StacyYang/MXNet-Gluon-Style-Transfer
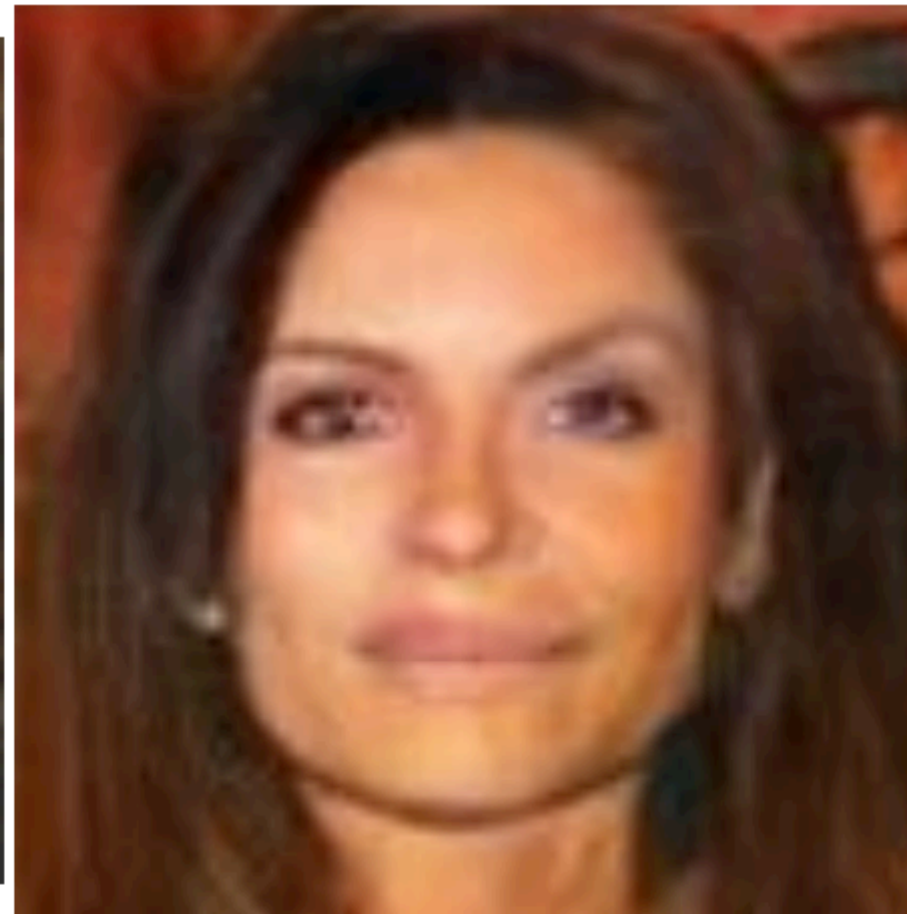
Generative Modeling

4.5 years of face generation

2014

2015

2016

2017

2018

Artificial Image Synthesis

Synthesize the images
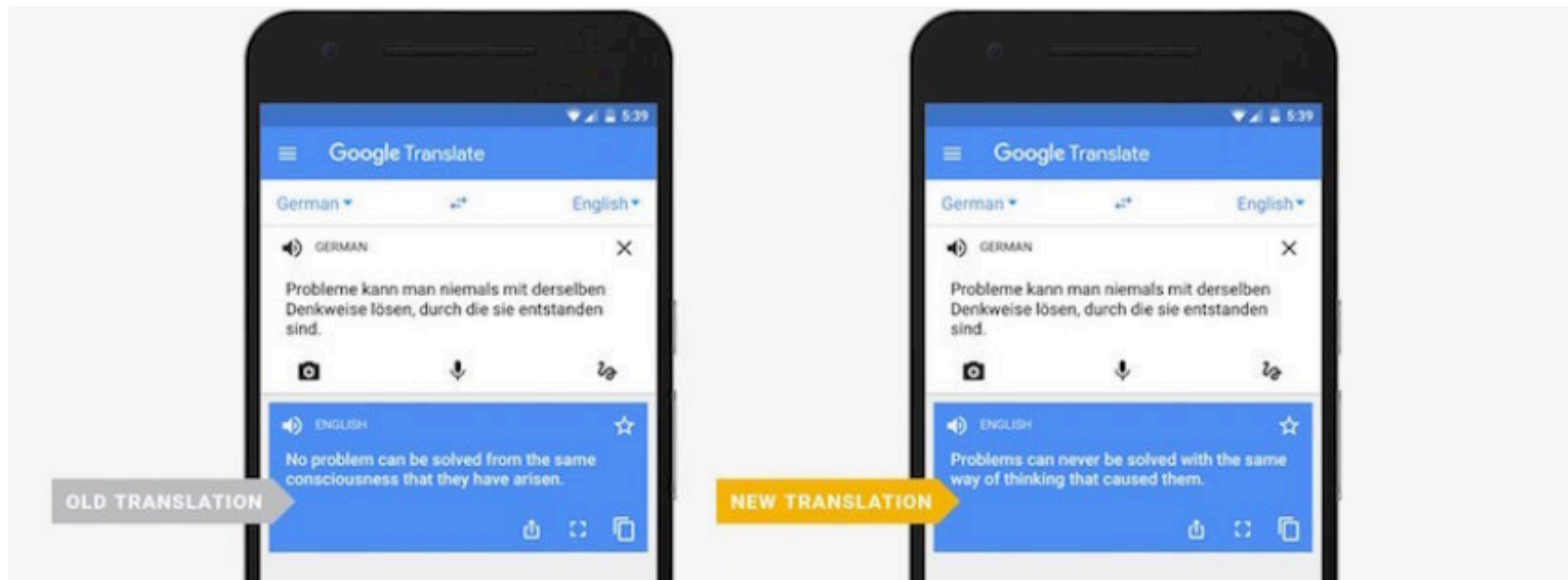
Machine Translation

https://www.pcmag.com/news/google-expands-neural-networks-for-language-translation

Google Expands Neural Networks for Language Translation

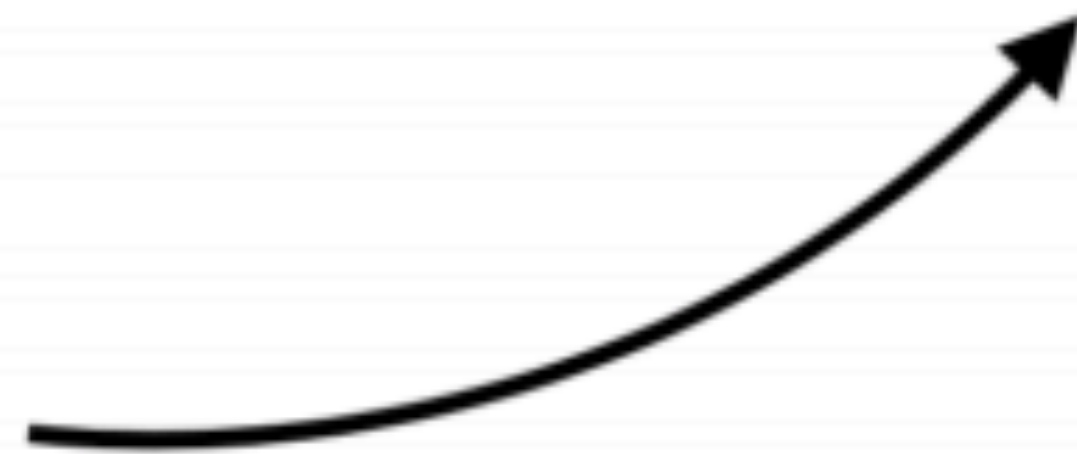The new system can translate whole sentences at a time, rather than just phrases.

By Tom Brant   November 15, 2016   f 🐦 ▣ ...

Text Synthesis

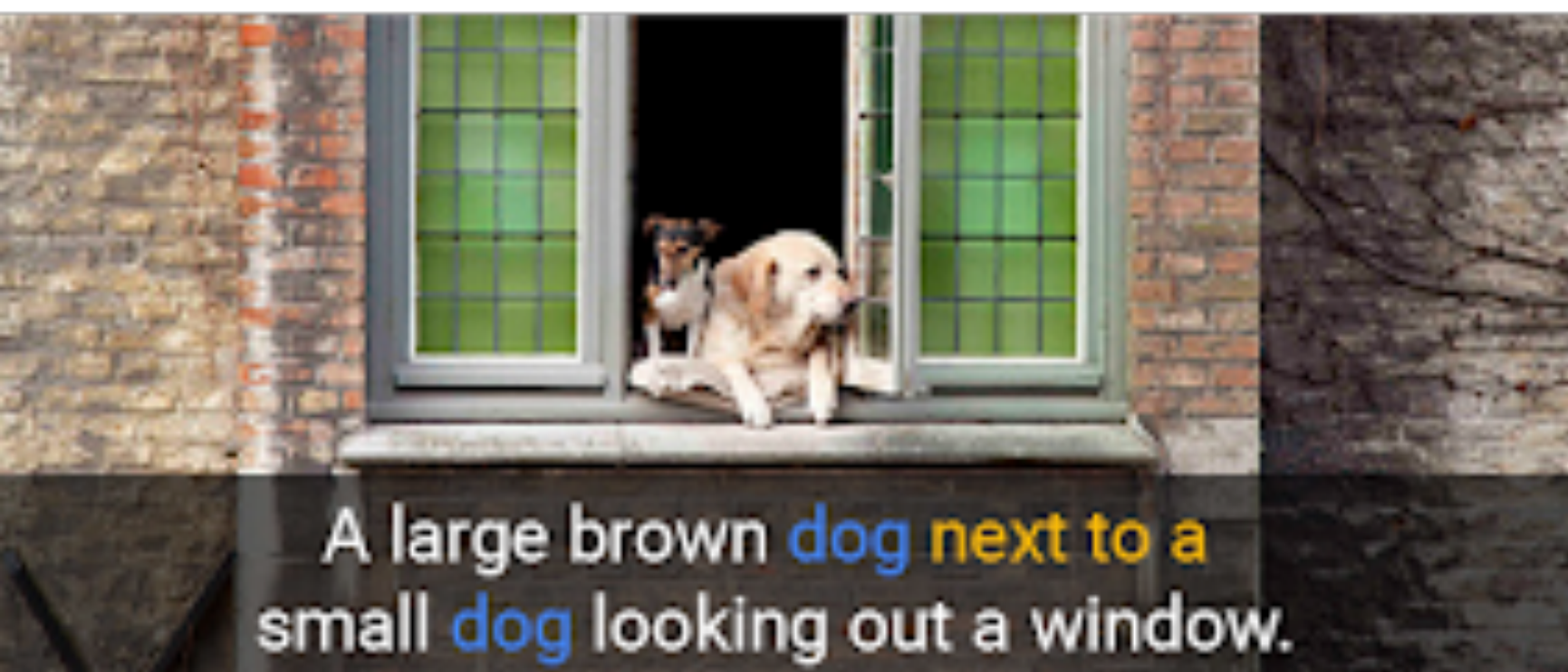Content: Two dogs play by a tree.

Style: happily, love

RNN

Two dogs in love play happily by a tree.

Li et al, NACCL, 2018

Image Captioning

https://ai.googleblog.com/2016/09/show-and-tell-image-captioning-open.html
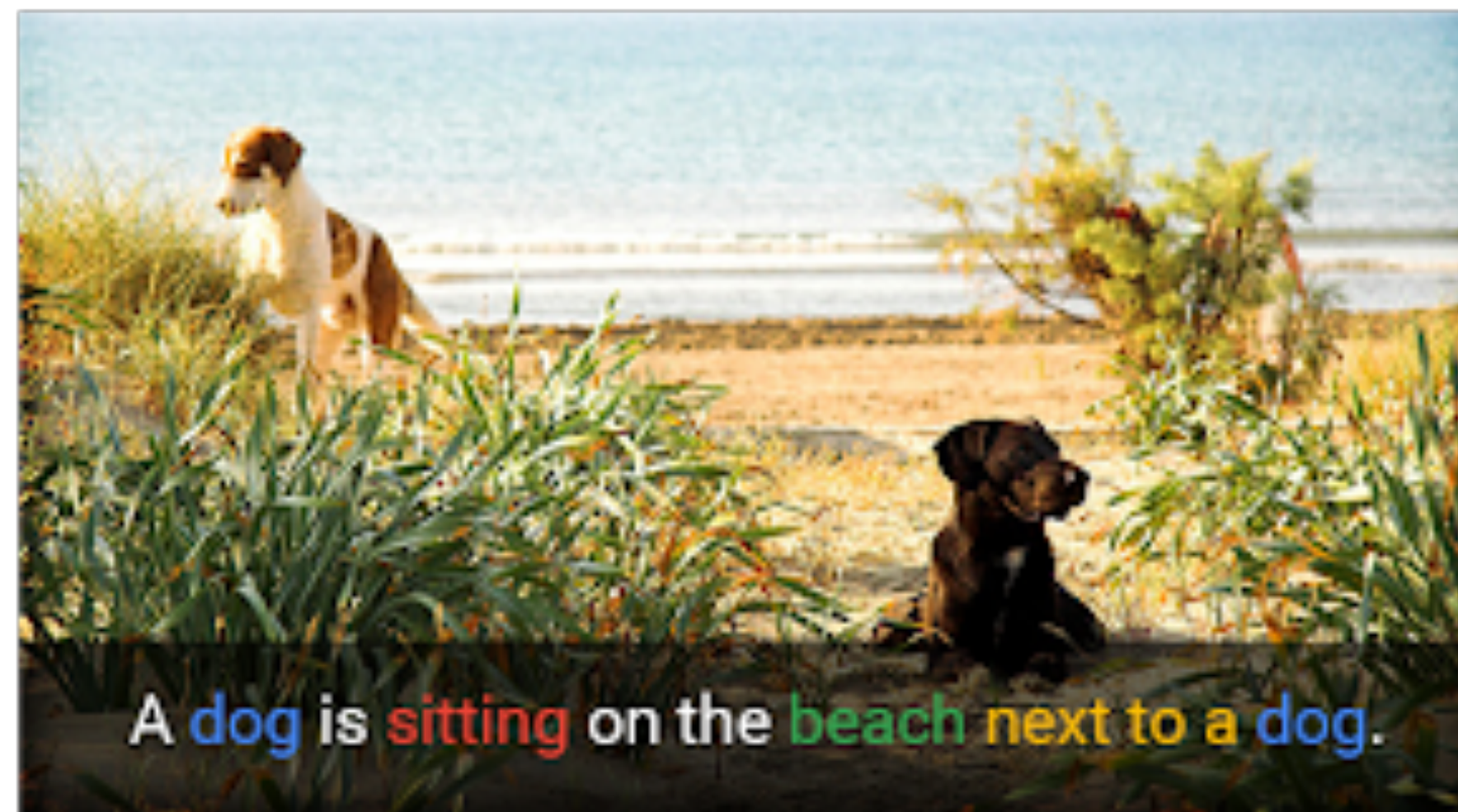
Open AI GPT-3: [Giving GPT-3 a Turing Test](#)

```
Q: What is your favorite animal?
A: My favorite animal is a dog.

Q: Why?
A: Because dogs are loyal and friendly.
```

Open AI GPT-3: [Giving GPT-3 a Turing Test](#)

Q: What is your favorite animal?
A: My favorite animal is a dog.

Q: Why?
A: Because dogs are loyal and friendly.

Q: What are two reasons that a dog might be in a bad mood?
A: Two reasons that a dog might be in a bad mood are if it is hungry or if it is hot.

Q: How many eyes does a giraffe have?
A: A giraffe has two eyes.

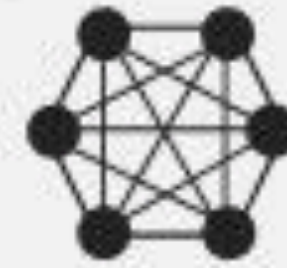**Q: How many legs does a frog have?**
A: A frog has four legs.
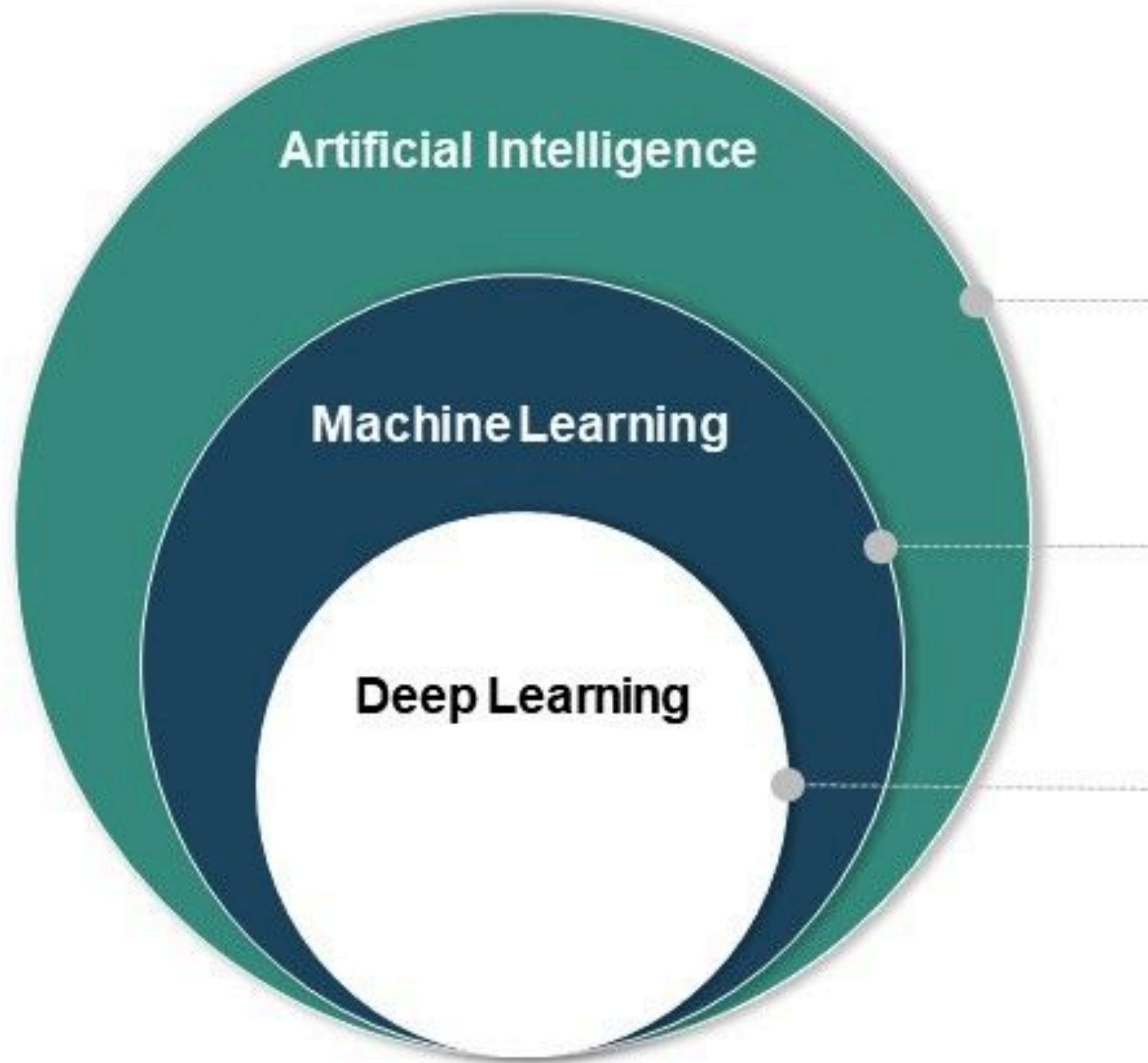
Q: Are there any animals with three legs?
A: No, there are no animals with three legs.

Q: Why don't animals have three legs?
A: Animals don't have three legs because they would fall over.

What is Artificial Intelligence (AI)?

Artificial Intelligence

Machine Learning

Deep Learning

Artificial Intelligence
Any technique which enables computers to mimic behavior.

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Any technique which enables computers to mimic behavior.

Machine Learning
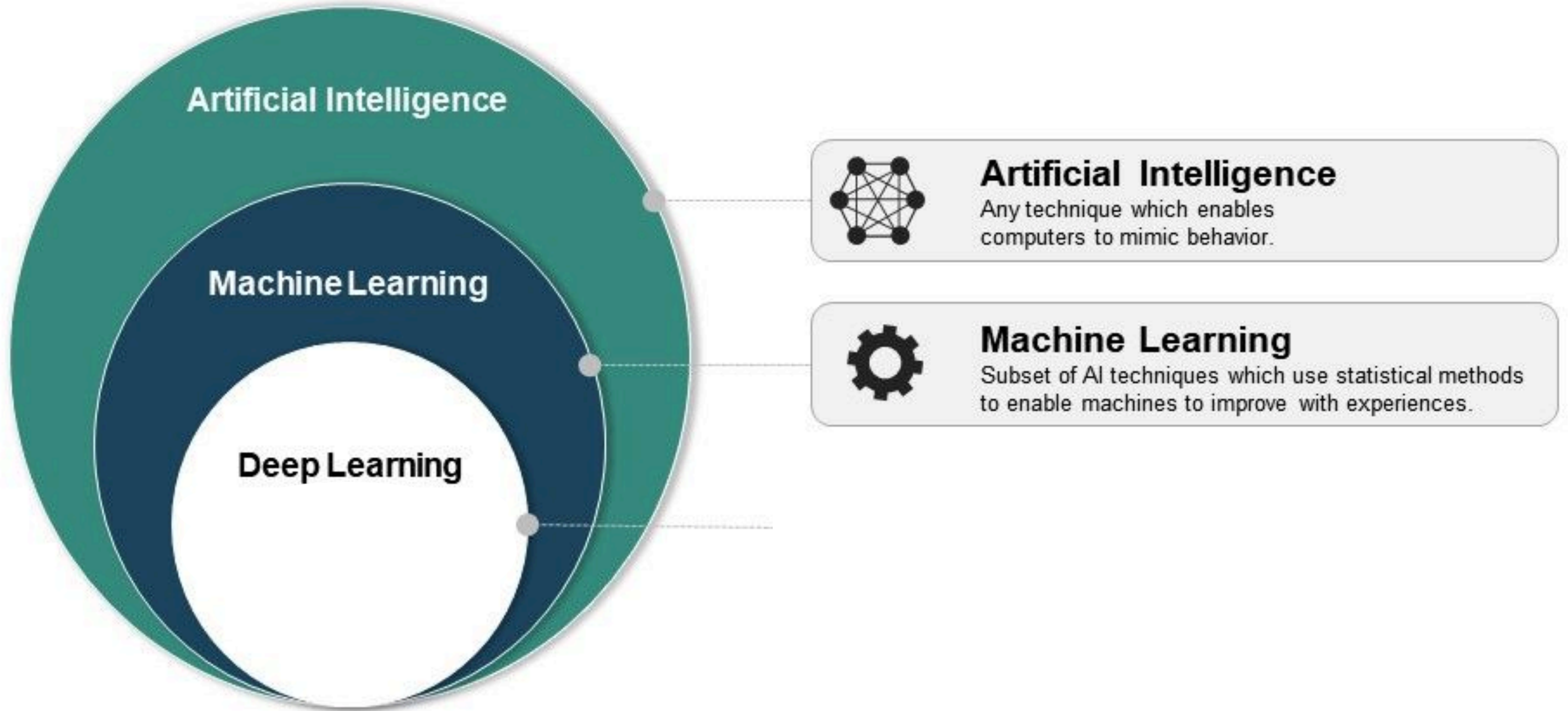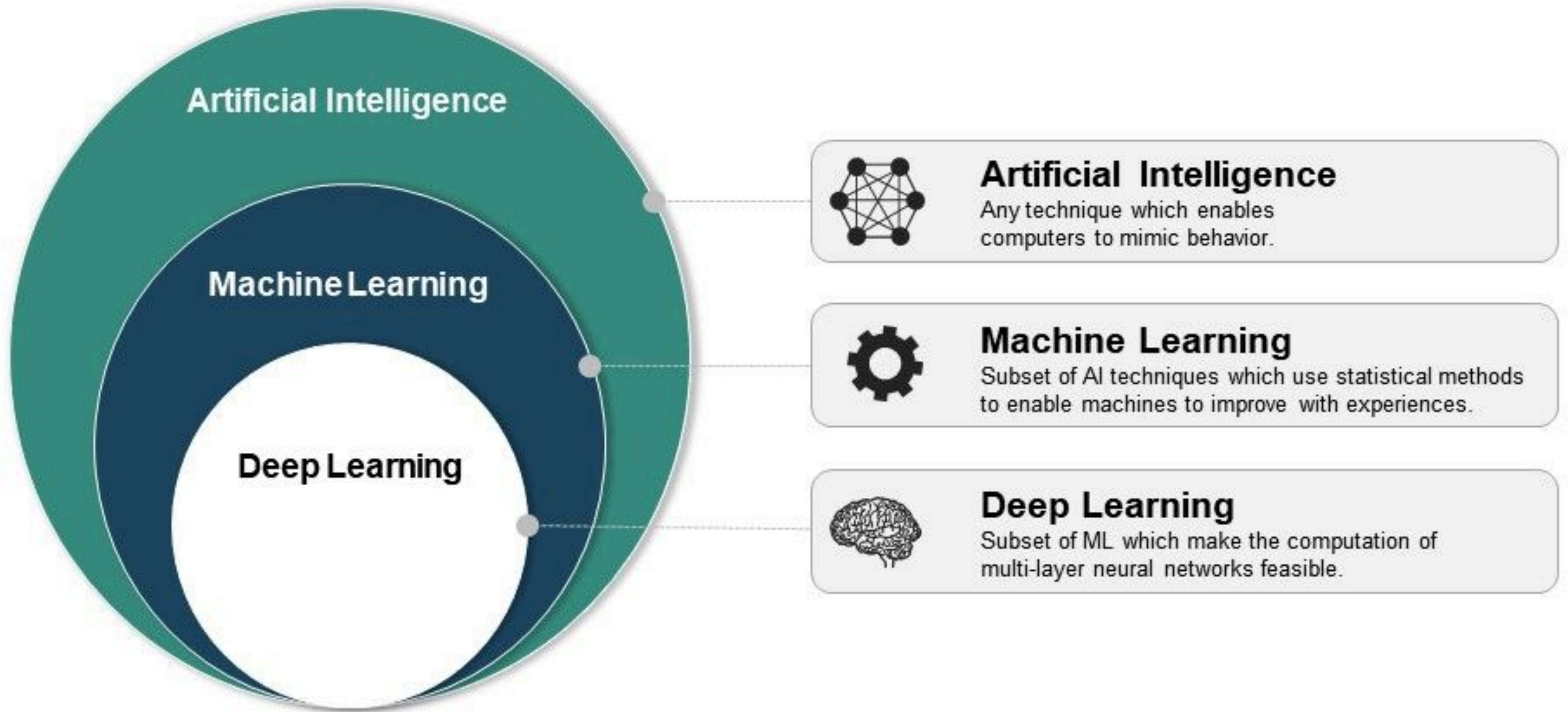Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

What is Artificial Intelligence (AI)?

Artificial Intelligence
Any technique which enables computers to mimic behavior.

Machine Learning
Subset of AI techniques which use statistical methods to enable machines to improve with experiences.

Deep Learning
Subset of ML which make the computation of multi-layer neural networks feasible.

Artificial Intelligence is not Magic

They rely on **fundamental** techniques in:

- Algorithms

- Mathematics

- Logic

- Probability and Statistics

- Optimization

What you can learn from CS540?

- Foundational tools in **Machine Learning** and **Artificial Intelligence**: Linear algebra, Probability, Logic, and elements of Statistics.

- Core techniques in **Natural Language Processing (NLP)**, including bag-of-words, tf-idf, n-Gram Models, and Smoothing.

- Basics of **Machine Learning**. supervised learning vs. unsupervised learning

- **Neural Networks and Deep Learning**: Network Architecture, Training, Backpropagation, Stochastic Gradient Descent.

- Fundamentals of **Game Theory**.

- **Search and Reinforcement Learning**

- **Artificial Intelligence** and **Machine Learning** in Real-World settings and the Ethics of Artificial Intelligence.

What you can learn from CS540?

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•Core techniques in **Natural Language Processing (NLP)**, including bag-of-words, tf-idf, n-Gram Models, and Smoothing.

TL;DR **Lots of useful stuff, theory and practice in AI**

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•**Neural Networks and Deep Learning**: Network Architecture, Training, Backpropagation, Stochastic Gradient Descent.

•Fundamentals of **Game Theory**.

•**Search and Reinforcement Learning**

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What you can learn from CS540?

https://pages.cs.wisc.edu/~yliang/cs540_1_fall21/schedule.html

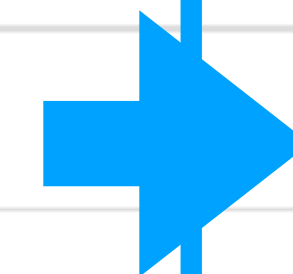| Date	Topic
Tuesday, Sept 14	Course Overview and Probability
Thursday, Sept 16	Linear Algebra and PCA
Tuesday, Sept 21	Statistics and Math Review
Thursday, Sept 23	Introduction to Logic
Tuesday, Sept 28	Natural Language Processing
Thursday, Sept 30	Machine Learning: Introduction
Tuesday, Oct 5	Machine Learning: Unsupervised Learning I
Thursday, Oct 7	Machine Learning: Unsupervised Learning II
Tuesday, Oct 12	Machine Learning: Linear regression
Thursday, Oct 14	Machine Learning: K - Nearest Neighbors & Naive Bayes
Tuesday, Oct 19	Machine Learning: Neural Network I (Perceptron)

Foundations

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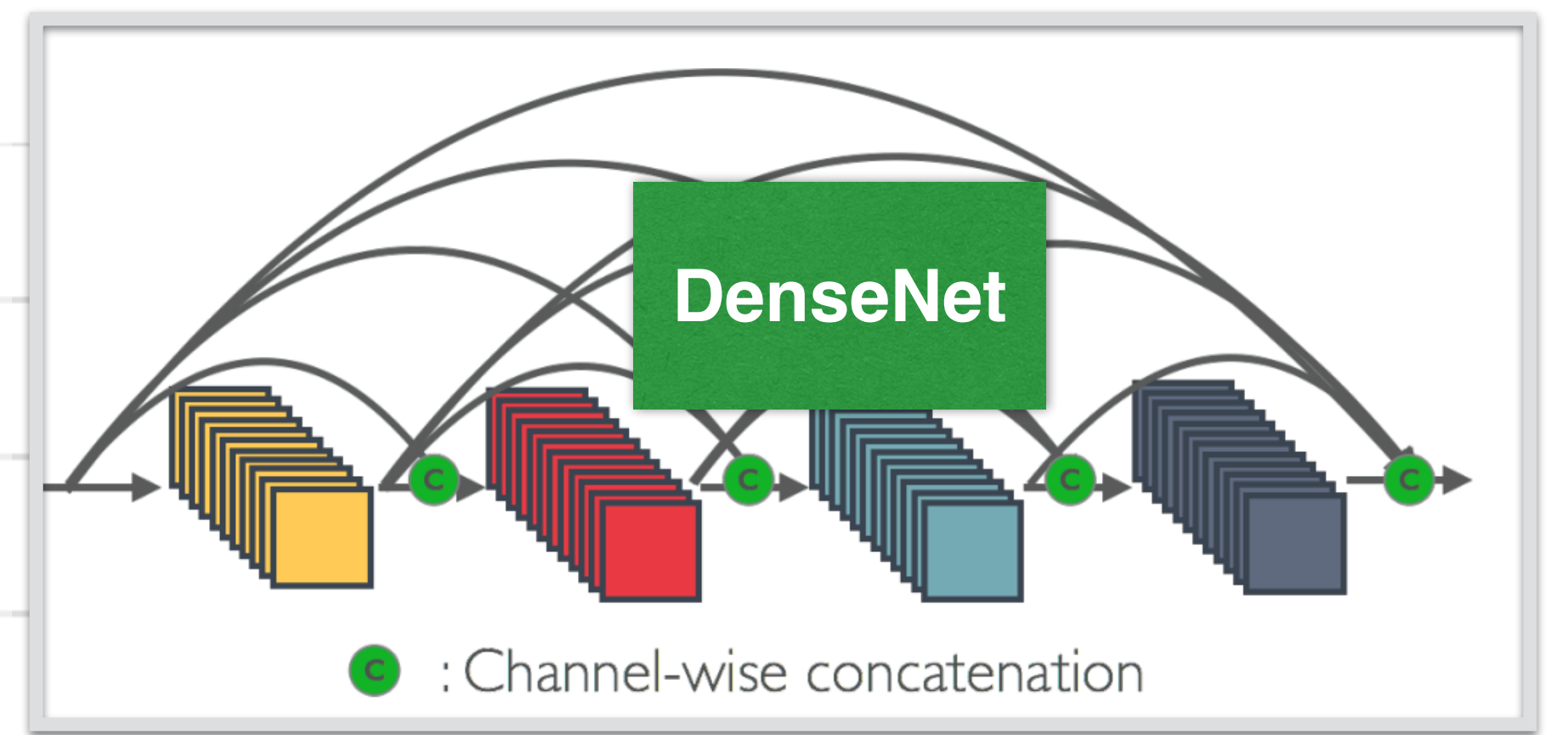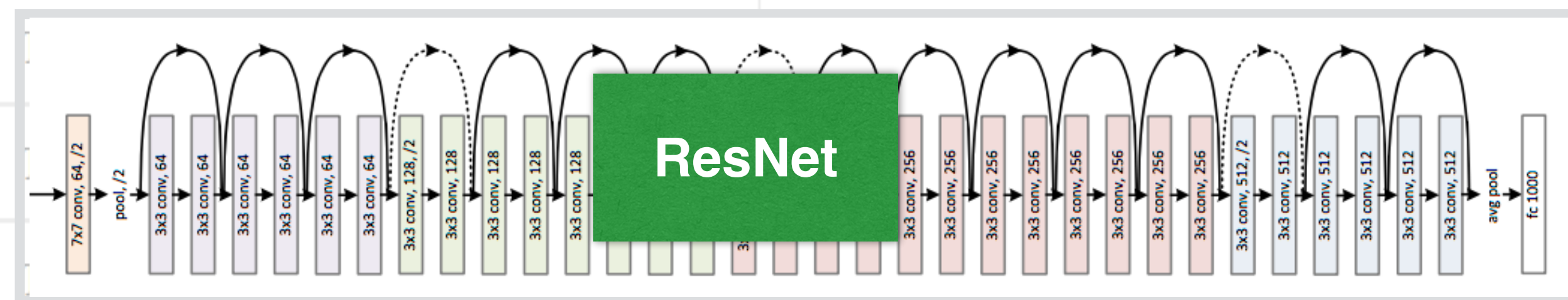| Date	Topic
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Machine learning

What you can learn from CS540?

Tuesday, Oct 19	Machine Learning: Neural Network I
Thursday, Oct 21	Machine Learning: Neural Network II
Tuesday, Oct 26	Machine Learning: Neural Network III
Tuesday, Nov 2	Machine Learning: Deep Learning I
Thursday, Nov 4	Machine Learning: Deep Learning II
Tuesday, Nov 9	Machine Learning: Deep Learning III
Thursday, Nov 11	Machine Learning: Deep Learning and Neural Network's Summary
Tuesday, Nov 16	Game - Part I
Tuesday, Nov 30	Advanced Search

Deep Learning

ResNet

DenseNet

c : Channel-wise concatenation

What you can learn from CS540?

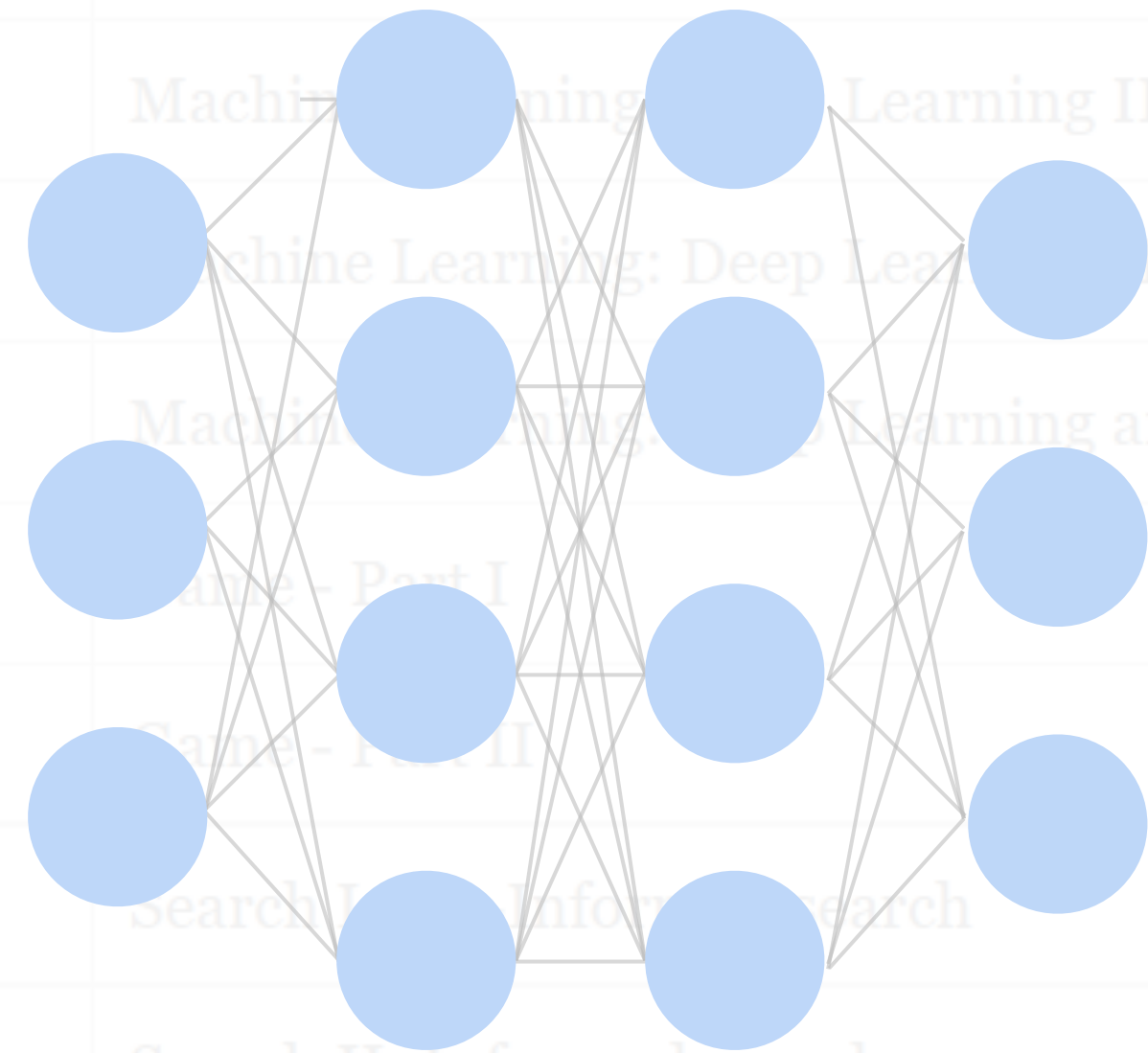|	
Tuesday, Nov 2	Machine Learning: Deep Learning I
Thursday, Nov 4	Machine Learning: Deep Learning II
Tuesday, Nov 9	Machine Learning: Deep Learning III
Thursday, Nov 11	Machine Learning: Deep Learning and Neural Network's Summary
Tuesday, Nov 16	Game - Part I
Thursday, Nov 18	Game - Part II
Tuesday, Nov 23	Search I: Un-Informed search
Thursday, Nov 25	Search II: Informed search
Tuesday, Nov 30	Advanced Search
Thursday, Dec 2	Introduction to Reinforcement Learning
Tuesday, Dec 7	Reinforcement Learning and Search Summary
Thursday, Dec 9	Ethics and Trust in AI
Tuesday, Dec 14	Artificial Intelligence in the Real World
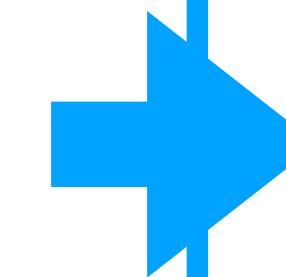
Game, search and RL

What you can learn from CS540?

Food Image Classifier

Training Data
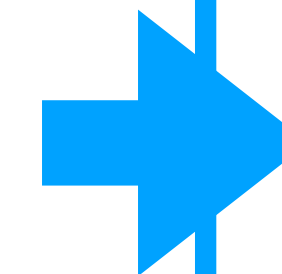
Real-world AI

Where to find content?

- **Piazza** piazza.com/wisc/fall2021/cs5401/home

  - Discussion, questions

  - Announcements

- **Canvas** - private materials *that should not be shared*

  - Videos

  - Assignments

  - Grades

- **Course website** - public materials

  - Slides https://pages.cs.wisc.edu/~yliang/cs540_1_fall21/

  - Schedule

  - Policies

Textbook

Artificial Intelligence: A Modern Approach (4th edition). Stuart Russell and Peter Norvig. Pearson, 2020. ISBN 978-0134610993. **(textbook is optional, but may be useful)**
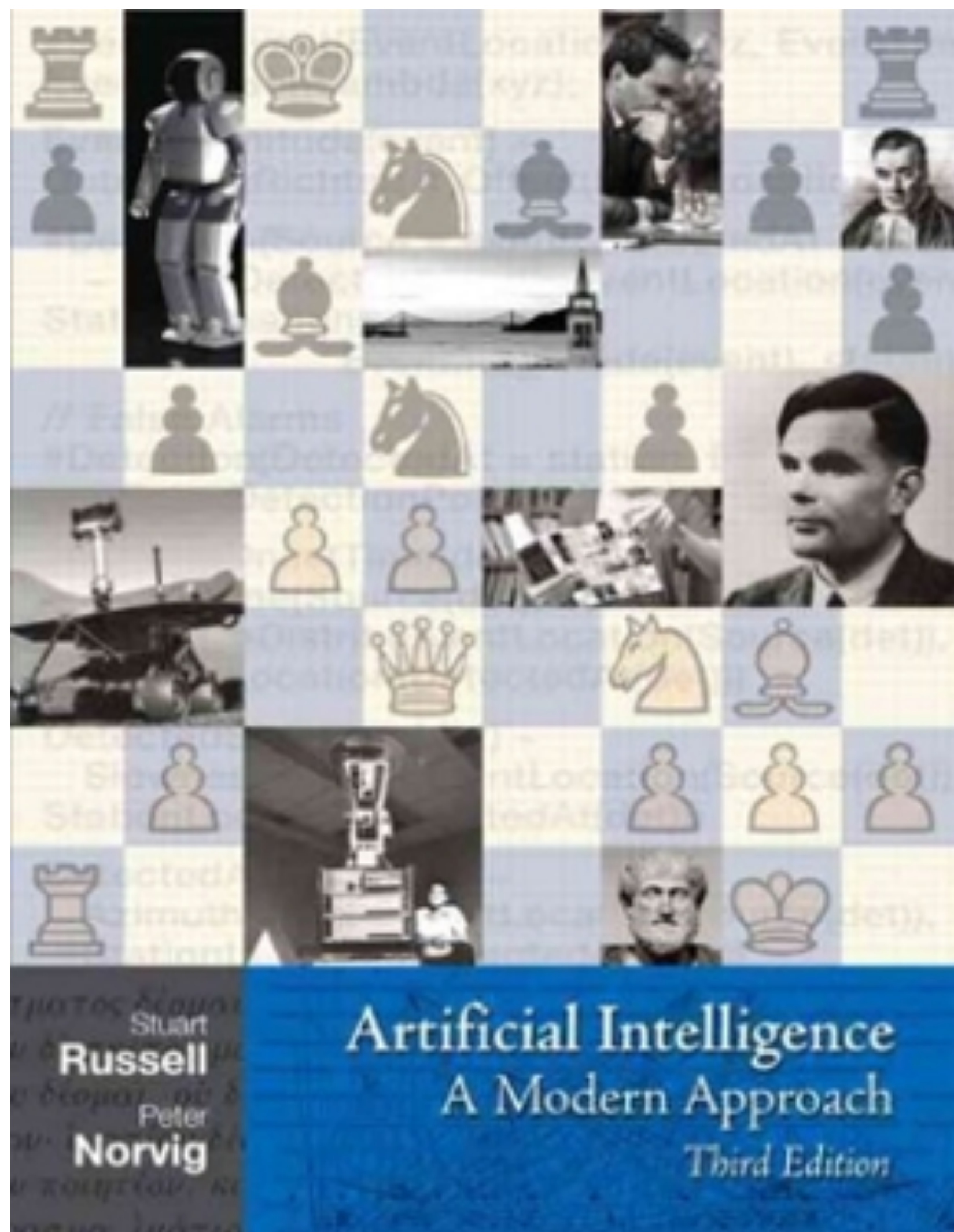
Grading scheme

- **Midterm Exam**: 15%

- **Final Exam**: 15%

- **Homework Assignments**: 70% (10 HWs)

TWO lowest homework scores are dropped from the final homework average calculation.

Homework is always due the minute before class starts on the due date.
(Late submissions will not be accepted.)

Homework will be posted and submitted via Canvas.

Office Hours

- Teaching team: 1 instructor, 3 TAs, 1 Grader, 12 Peer Mentors

- Office hours: http://pages.cs.wisc.edu/~yliang/cs540_1_fall21/office_hours.html

- Use Peer Mentor hours for detailed-level questions (e.g. coding related), and use TA office hours for conceptual level questions

Regrade Request

Use Google Form for regrade request

Raised with the TAs within 72 hours after it is returned.

Integrity

You are encouraged to discuss with your peers, the TA or the instructors ideas, approaches and techniques broadly. However, all examinations, programming assignments, and written homeworks must be written up individually. For example, code for programming assignments must not be developed in groups, nor should code be shared. Make sure you work through all problems yourself, and that your final write-up is your own. If you feel your peer discussions are too deep for comfort, declare it in the homework solution: "I discussed with X,Y,Z the following specific ideas: A, B, C; therefore our solutions may have similarities on D, E, F...".

You may use books or legit online resources to help solve homework problems, but you must always credit all such sources in your writeup and you must never copy material verbatim.

We are aware that certain websites host previous years' CS540 homework assignments and solutions against the wish of instructors. Do not be tempted to use them: the solutions may contain "poisonous berries" previous instructors planted intentionally to catch cheating. If we catch you copy such solutions, you automatically fail.

Do not bother to obfuscate plagiarism (e.g. change variable names, code style, etc.) One application of AI is to develop sophisticated plagiarism detection techniques!

Cheating and plagiarism will be dealt with in accordance with University procedures (see the UW-Madison Academic Misconduct Rules and Procedures)

Software Tools

- **Python**
  - Everyone is using it in machine learning & data science
  - A Crash course in Python (self-study): Link
- **Jupyter**
  - So much easier to keep track of your experiments
  - Obviously you should put longer code into modules
- **Colab**
  - Go to colab.research.google.com
  - Activate the GPU supported runtime

Thanks!